U.S. Army Center for Health Promotion and Preventive Medicine

USCHPPM

DEVELOPMENT OF A DEPLOYMENT INJURY SURVEILLANCE SYSTEM USING MEDICAL AIR EVACUATION DATA

TECHNICAL REPORT NO. 12-HF-056S-07

U.S. Army Center for Health Promotion and Preventive Medicine
Aberdeen Proving Ground, MD

CHPPM FORM 43

Readiness Thru Health

U.S. ARMY CENTER FOR HEALTH PROMOTION AND PREVENTIVE MEDICINE

The U.S. Army Center for Health Promotion and Preventive Medicine (USACHPPM) lineage can be traced back over 50 years to the Army Industrial Hygiene Laboratory. That organization was established at the beginning of World War II and was under the direct jurisdiction of The Army Surgeon General. It was originally located at the Johns Hopkins School of Hygiene and Public Health, with a staff of three and an annual budget not to exceed $3000. Its mission was to conduct occupational health surveys of Army operated industrial plants, arsenals, and depots. These surveys were aimed at identifying and eliminating occupational health hazards within the Department of Defense's (DOD) industrial production base and proved to be beneficial to the Nation's war effort.

Until 1995, it was nationally and internationally known as the U.S. Army Environmental Hygiene Agency or AEHA. Its mission is expanding to support the worldwide preventive medicine programs of the Army, DOD and other Federal Agencies through consultations/ supportive services; investigations and training.

Today, AEHA is redesignated the U.S. Army Center for Health Promotion and Preventive Medicine. Its mission for the future is to provide worldwide technical support for implementing preventive medicine, public health and health promotion/wellness services into all aspects of America's Army and the Army Community anticipating and rapidly responding to operational needs and adaptable to a changing work environment.

The professional disciplines represented at the Center include chemists, physicists, engineers, physicians, optometrists, audiologists, nurses, industrial hygienists, toxicologists, entomologists, and many other as well as sub-specialties within these professions.

The organization's quest has always been one of excellence and continuous quality improvement; and today its vision, to be the nationally recognized Center for Health Promotion and Preventive Medicine, is clearer than ever. To achieve that end, it holds ever fast to its values which are steeped in its rich heritage:

- *Integrity is the foundation*
- *Excellence is the standard*
- *Customer satisfaction is the focus*
- *Its people are the most valued resource*
- *Continuous quality improvement is its pathway*

The organization, which stands on the threshold of even greater challenges and responsibilities, has General Officer leadership. As it moves into the next century, new programs are being added related to health promotion/wellness, soldier fitness and disease surveillance. As always, its mission focus is centered upon the Army Imperatives so that we are trained and ready to enhance the Army's readiness for war and operations other than war.

It is an organization fiercely proud of its history, yet equally excited about the future. It is destined to continue its development as a world-class organization with expanded services to the Army, DOD, other Federal Agencies, the Nation and the World Community.

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14. ABSTRACT
In May 2005, the U.S. Army Center for Health Promotion and Preventive Medicine was tasked by the Deputy Assistant Secretary of the Army for Environment, Safety and Occupational Health to develop an injury surveillance system for deployed Army Soldiers. A primary objective was to develop a system capable of identifying types and potentially preventable causes of injuries requiring medical air evacuation. The primary data source for air evacuated injured Soldiers was the U.S. Transportation Command Regulating and Command & Control Evacuation System (TRAC^{2}ES) which included standardized diagnosis codes and a free-text patient history from which details for injury causes could be obtained. TRAC^{2}ES data were linked to data from the Defense Casualty Reporting System (DCIPS) and the Army Safety Management Information System (ASMIS) to obtain additional details for the injury causes and circumstances. Since information on injury causes was in free-text fields, coders reviewed each air evacuation case and applied a standardized coding scheme (STANAG) to classify causes of injury. The final enhanced air evacuation data system included 1) linked data from TRAC2ES, DCIPS and ASMIS and 2) coded causes and types of injuries. This system provided high quality, analysis-ready data and is well suited for deployment injury surveillance.

15. SUBJECT TERMS
injury, non-battle injury, injury causes, surveillance, deployment

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EXECUTIVE SUMMARY

DEVELOPMENT OF A DEPLOYMENT INJURY SURVEILLANCE SYSTEM USING MEDICAL AIR EVACUATION DATA TECHNICAL REPORT NO. 12-HF-056S-07

1. REFERENCES. Appendix A.

2. INTRODUCTION.

a. Non-battle injuries (NBIs) are a major cause of morbidity and mortality during combat operations. Whereas disease was the leading cause of hospitalization in World Wars I and II, [1,2] beginning with the Vietnam War, NBIs became the leading type of casualty[3,4]. During Operations Desert Shield and Desert Storm (1990-1991), Writer et al.[5] reported that unintentional trauma and musculoskeletal conditions accounted for 38% of all hospitalizations. Of all NBIs, motor vehicle crashes (19%), falls (19%), and sports activities (18%) were the top three causes. Finally, the critical importance of NBIs was highlighted by Writer's finding that 81% of deaths were caused by unintentional trauma, of which 34% were due to motor vehicle crashes.

b. Even though the impact of NBIs has become well recognized during military operations, the epidemiology of these injuries, many of which may be preventable, has been poorly understood. During past conflicts, evaluation of these injuries has only occurred after the conflicts ended, too late to have an impact during the operation. Being able to identify and classify NBIs by type (diagnosis) and cause while the conflict is on-going is an important step in trying to reduce the significant burden of these injuries.

3. PURPOSE. The purpose of this report is to describe the methods employed by the Injury Prevention Program to develop an enhanced air evacuation database suitable for deployment injury surveillance. Specifically, this report describes 1) the data sources accessed to create an enhanced surveillance database for injuries requiring medical air evacuation, 2) the coding scheme used to classify (code) causes of injury and other important injury details from the data, 3) the process employed to identify injury types and causes in the enhanced database, and 4) the improved data quality of this deployment injury surveillance system compared to the original air evacuation data.

4. AUTHORITY. The Injury Prevention Program, U.S. Army Center for Health Promotion and Preventive Medicine (USACHPPM) was tasked by the Deputy Assistant Secretary of the Army for Environment, Safety and Occupational Health in May 2005 to conduct a deployment injury surveillance project for U.S. Army Soldiers (Appendix B). The focus of this project was to 1)

develop a system capable of identifying the types and potentially preventable causes of NBIs requiring medical air evacuation from Operations Enduring Freedom (OEF) and Iraqi Freedom (OIF), 2) describe the relative magnitude of the NBI problem compared to battle injuries (BIs) and illness or other medical conditions and 3) describe the types and causes of NBIs that required air evacuation. The analysis and results of this project for OEF and OIF will be presented in subsequent reports.

5. METHODS.

a. **Subjects and Case Definition.** A case was any Soldier (i.e., regular Army, Reserve, and National Guard) medically air evacuated from OEF or OIF for an injury (BI or NBI) since the beginning of the operations (OEF: October 2001; OIF: 19 March 2003) through June 2006.

b. **Primary Source of Medical Air Evacuation Data.** Information about medical air-evacuations was obtained from an administrative data system maintained by the U.S. Transportation Command (TRANSCOM) to schedule and conduct medical air evacuations worldwide. This system, the TRANSCOM Regulating and Command & Control Evacuation System ($TRAC^2ES$) included demographic and administrative information on each person being medically air evacuated for injury, illness, or other medical conditions. Most importantly for this project, $TRAC^2ES$ also had basic medical information that included:

(1) Standardized diagnosis codes which could be used to classify injuries into primary injury types and

(2) A detailed (free-text) patient history that would be the primary source of information to identify and classify causes of injury. To be useful, however, this information would have to be reviewed and coded in the enhanced air evacuation database.

c. **Additional Data Sources.** Two additional data systems were identified that increased the amount of detail available to coders on injury types and causes. These data sources were the 1) Defense Casualty Information Processing System (DCIPS) and 2) Army Safety Management Information System (ASMIS). The most useful injury detail in these systems, however, was in free-text fields. Although not all air evacuation cases had corresponding records in these other data systems, the increased detail available when cases were in one or both of these data systems proved extremely valuable to coders when coding causes of injury.

d. **Development of the Enhanced Air Evacuation Injury Surveillance Database.** The development of an enhanced air evacuation relational database was central to this deployment injury surveillance project.

(1) The $TRAC^2ES$ air evacuation data were imported into a Microsoft (MS) Access data table. Data fields from DCIPS and ASMIS that would provide additional detail for causes of injury were also imported into data tables in the MS Access file. A relational database was then created linking the three data sources ($TRAC^2ES$, DCIPS, and ASMIS). Not all $TRAC^2ES$ records linked to records in DCIPS and/or ASMIS.

(2) The main enhancement of the TRAC^{2}ES air evacuation data for use as an injury surveillance tool would be the addition of coded (categorized) causes of injury.

e. **Injury Cause Coding Scheme.**

(1) The primary cause coding scheme used for this deployment injury surveillance system was developed in the 1950s by the countries comprising the North Atlantic Treaty Organization (NATO) to classify causes of injuries that required hospitalization. In 1989, NATO approved a revision of this cause coding scheme that was described in the NATO Standardization Agreement (STANAG) No. 2050, 5th Edition and commonly referred to as the STANAG coding scheme.

(2) Additional coded variables were developed for the enhanced air evacuation database. These variables enabled coders to classify other important details for air evacuated injuries (BIs and NBIs). The addition of these coded variables improved the injury analysis capabilities of this database.

f. **Data Entry Using MS Access Interface.**

(1) A MS Access data entry form was created that allowed coders to easily review relevant data fields from the enhanced air evacuation database (TRAC^{2}ES, DCIPS and ASMIS). This interface greatly facilitated the coders' work in 1) reviewing relevant data fields for each air evacuation case and 2) coding causes of injury (STANAG codes) and the other injury variables developed for this system.

(2) During the coding process, the TRAC2ES free-text patient history field was the primary source of information for causes of injury. In some cases, additional information was available from DCIPS and/or ASMIS.

6. RESULTS.

The results section of this report describes the improvements in data quality that resulted from the development of the enhanced air evacuation database that included coded (categorized) causes of injury. Specifically, examples are provided demonstrating how these enhancements positively affected the overall data quality of this system by improving its 1) utility as a near-real time deployment injury surveillance system with coded injury types and causes, 2) accuracy achieved through the injury coding process, and 3) data completeness by maximizing the strengths of three systems (TRAC^{2}ES, DCIPS, and ASMIS) and transcription of text fields into coded variables.

7. CONCLUSION.

a. The enhanced air evacuation database developed for this project has high quality data, is analysis-ready, and allows surveillance of injuries requiring medical evacuation during deployments. The case ascertainment of TRAC^{2}ES is complete, including virtually every Soldier evacuated for injuries, making it well suited for injury surveillance. TRAC^{2}ES data was

supplemented with cause of injury detail from DCIPS and ASMIS. While TRAC^{2}ES included standardized diagnosis codes, critically important cause of injury data was accessible only in the free-text fields (TRAC^{2}ES, DCIPS and ASMIS) which were not suited for quantitative analysis. The enhanced database, however, overcame this obstacle to data utility by establishing STANAG cause codes for each injury case.

b. To reliably prevent injuries, knowledge of the causes of injuries is essential. Thus, the primary benefit derived from this enhanced deployment injury surveillance system is readily accessible automated data, not just for the diagnosis (types) of injuries, but also for the causes of those injuries.

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b. **Primary Source of Medical Air Evacuation Data.**

(1) Information about medical air-evacuations was obtained from an administrative data system maintained by the U.S. Transportation Command (TRANSCOM) to schedule and conduct medical air evacuations worldwide. This system, the TRANSCOM Regulating and Command & Control Evacuation System ($TRAC^2ES$) included demographic information on each person being medically air evacuated, including personal identifiers, age, gender, and branch of service. It also included administrative details about the air evacuation including the date of the air evacuation, originating medical facility and military command (e.g. CENTCOM), and the destination medical facility and military command (e.g. European Command). Most importantly for this deployment injury surveillance project, $TRAC^2ES$ also had basic medical information that included:

(a) Diagnosis codes from the International Classification of Diseases, 9^{th} Revision – Clinical Modification (ICD-9-CM) which would be used to classify injuries into primary injury types and

(b) A detailed (free-text) patient history.

(2) The primary source of information on cause of injury for this deployment injury surveillance project was the free-text patient history field in $TRAC^2ES$. To be useful, however, this information would have to be reviewed and coded in the enhanced air evacuation database.

(3) Most air evacuees in $TRAC^2ES$ had multiple air evacuation movements as part of their continuum of medical care. For example, a Soldier who was assigned at Ft. Campbell, KY prior to the deployment may have been air evacuated from the combat support hospital in Baghdad, Iraq to Landstuhl Regional Medical Center in Germany, and finally to Walter Reed Army Medical Center in Washington DC. Each of these air evacuation movements had a $TRAC^2ES$ record (separate row of data) that could be linked by the evacuee's personal identifiers. For the $TRAC^2ES$ data to be useful in the deployment injury surveillance system, it was first necessary to re-structure this "vertical" database by transposing important data fields from all records for a given evacuee to a single record (row of data). This created a more useful "horizontal" database with one record per person.

c. **Additional Data Sources.** Two additional data systems were identified that increased the amount of detail available to coders on injury types and causes. These data sources were the 1) Defense Casualty Information Processing System (DCIPS) and (2) Army Safety Management Information System (ASMIS). The most useful injury detail in these systems, however, was in free-text fields. Although not all air evacuation cases had corresponding records in these other data systems, the increased detail available when cases were in one or both proved extremely

valuable to coders in understanding and coding causes of injury. Information in DCIPS and ASMIS also served to validate injury information in the TRAC^{2}ES patient history.

(1) DCIPS. The proponent agency for DCIPS is the Casualty and Memorial Affairs Operations Center, U.S. Army Human Resources Command. It is the official Department of Defense casualty reporting system. It presumably includes records for all casualties resulting from hostile (battle) action, all non-hostile (non-battle) fatalities (injury- or illness-related), and the most serious non-hostile (non-battle) injury- and illness-related casualties that are categorized as very seriously injured or ill. Importantly for this deployment injury surveillance project, DCIPS included a free-text variable describing the circumstances and cause of injury for the battle and non-battle injury cases.

(2) ASMIS. The proponent agency for ASMIS is the U.S. Army Combat Readiness Center. It is an accident investigating and reporting system for ground and aviation accidents (non-battle). Even though ASMIS does include all serious accident (injury) cases including death and permanent disability, it does not capture all minor accidents that result in limited duty. ASMIS has been found, however, to be a useful tool in identifying injury causes and circumstances for those accidental injuries that it does investigate and report[6].

d. **Development of the Enhanced Air Evacuation Injury Surveillance Database.**

(1) The parent TRAC^{2}ES database was filtered to exclude Air Force, Navy, and Marine Corps evacuees. The filtered database in the horizontal format was then imported into a data table in Microsoft (MS) Access. Data fields from DCIPS and ASMIS that would be useful in supplementing the air evacuation data with details for cause of injury and other injury facts were also imported into data tables in the MS Access file. A relational database was then created linking these data tables (TRAC^{2}ES air evacuation data, DCIPS, and ASMIS). Not all air evacuation records linked to records in DCIPS and ASMIS, but the additional detail was very useful when records did link with DCIPS and/or ASMIS. For the remainder of this report, the relational database consisting TRAC^{2}ES air evacuation data linked to DCIPS and ASMIS is referred to as the "enhanced air evacuation database".

(2) The development of the enhanced air evacuation relational database was central to this deployment injury surveillance project. Data coders were then able to review all available data in a MS Access data entry form (described below) in order to make the coding decisions critical to this project.

(3) The main enhancement of the TRAC^{2}ES air evacuation data for use as an injury surveillance tool would be the addition of coded (categorized) causes of injury.

e. **Coding Scheme for the Enhanced Air Evacuation Database.**

(1) Cause of injury coding scheme.

(a) A primary objective of this project was to identify potentially preventable causes of non-battle injuries (NBIs) requiring air evacuation from OEF and OIF. In the TRAC^{2}ES air

evacuation data, however, cause of injury was not available as a coded variable. A pilot evaluation of the TRAC^{2}ES air evacuation data in December 2003 demonstrated the feasibility of using the free-text patient history field to identify and classify causes of injury[7]. This pilot evaluation also demonstrated the feasibility of using an established military injury cause coding scheme that was developed for use by the North Atlantic Treaty Organization (NATO).

(b) In the 1950s, the NATO countries agreed upon and accepted a coding scheme to classify causes of injury that required hospitalization. In 1989, a revision of the injury codes was approved by the nine countries comprising NATO. This coding scheme was described in the NATO Standardization Agreement (STANAG) No. 2050, 5th Edition and was commonly referred to as the STANAG coding scheme[8]. This scheme was especially useful to the military because it captured injury causes of substantial importance to the armed forces, such as war-related injuries[9,10]. This coding scheme will be referred to as the "STANAG coding scheme" for the remainder of this report.

(c) The STANAG codes are a four digit code describing the intent/situation, injury cause, and where the injury occurred. The first digit is called the "trauma" code (see Table 1). It is independent of the last three digits and represents the type of injury that occurred (battle, intentional non-battle or accidental non-battle). In most cases, the second through fourth digits represent the cause of injury, giving identification to the specific causative agent (see Table 2). However, some injuries only have the second and third digits as standard while the fourth digit is interchangeable according to the place the injury occurred. This fourth digit, the "place code" (see Table 3), is needed for codes 500-999.

Table 1. STANAG Trauma Codes

Trauma Classification	Code	Code Description
Battle Wound or Injury	0	Direct result of action by or against enemy
	1	Indirect result of action by or against enemy
Intentional non-battle injuries	2	Result of intervention by legal authority
	3	Assault or intentionally inflicted by another
	4	Intentionally self-inflicted
Unintentional (accidental) non-battle injuries	5	Occurring while off duty*
	6	Schemes and exercises
	7	All other scheduled training and assault courses
	8	Occurring while on duty
	9	Unknown whether on or off duty*

*Off-duty means that the service member was on leave or absent without leave (AWOL).

Table 2. STANAG Cause of Injury Codes

Category	Major Code Groupings	Minor Code Groupings	Description
I	000-059		Accidents in air transport
		000-029	Involving military aircraft
		030-039	Involving non-military and unspecified aircraft
		051-057	Escape system injuries
II	100-149		Accidents in land transport
		100-109	Private vehicle (traffic)
		110-119	Military vehicles (traffic)
		120-129	*Non-traffic private vehicles
		130-139	*Non-traffic military vehicles
III	150-199		Accidents in water transport
IV	200-249		Athletics and sports, includes physical training
V	250-299		Reactions and complications in medical or surgical procedures, late complications or late effects
VI	300-479		Instrumentalities of war (IOW), when employed by the enemy during war-time
		460-479	Indirect or secondary effects of IOW
VII	480-499		Accidents in connection with IOW, when employed as such in wartime
VIII	50*-59*		Guns, explosives and related agents, not used as IOW in wartime
IX	60*-69*		Machinery, tools and selected agents
X	70*-79*		Poisons, fire, hot or corrosive substances
XI	80*-89*		Specified environmental factors
XII	90*-99*		Falls and miscellaneous other or unspecified agents

*Require a "place code"

Table 3. STANAG Place Codes.

Code	Place of Occurrence of Injury
0	On board an aircraft
1	On board a ship
2	On land, at an airfield
3	On land, at a boat dock
4	On land, at an industrial plant, repair shop, etc.
5	On land, on a firing range or a drill field
6	On land, at an obstacle course
7	On land, in a kitchen, mess-hall or bakery
8	On land, in quarters or barracks
9	On land, unspecified location

(2) Additional coded variables developed for this project. In addition to the STANAG cause code for each injury, additional variables were created for the enhanced air evacuation database that would enable coders to classify other important details for injuries (BIs and NBIs). These new variables are described below:

(a) An additional free-text field that provided a very brief summary of what is known about each injury incident.

(b) Anatomic location of the injury.

(c) For the STANAG cause code for falls/jumps, a new field was created that coded falls and jumps separately, based strictly on whether a "fall" or a "jump" was specifically cited in a given patient history. This new field also provided a code for "near-fall", defined as any injury STANAG-coded as a twist/slip/trip but excluding twist injuries initiated by a voluntary twisting of the body (e.g., when reaching for something). This new field for falls, near-falls and jumps included injury cases where the evacuee was injured by falling or jumping while boarding or alighting a vehicle. For the above fall, near-fall and jump injuries, more detailed information was captured about (1) activity at time of injury (list types), (2) injury mechanism (list types), and (3) contributing factors.

(d) The STANAG coding for motor vehicle related injuries was expanded to include injuries that occurred during the normal operation of a vehicle, jumping or falling from a stationary vehicle and battle injuries to occupants of a vehicle. These new fields consisted of (1) vehicle type, (2) accident crash type and (3) whether the vehicle was armored (if battle injury).

(e) For injuries that actually occurred prior to the deployment, the exacerbating cause of injury that resulted in the Soldier being air evacuated from OEF and OIF was coded using the STANAG cause code. An additional field was added that also captured the cause of the original pre-deployment injury, when available.

(f) A field was added to capture a secondary STANAG code to be used when a primary cause (e.g., sports) could also have a secondary cause (e.g., a Soldier fell while playing basketball).

f. **Data Entry Using a MS Access Interface.**

(1) The process of reviewing the data fields from TRAC^{2}ES, DCIPS and ASMIS for every air evacuation case and coding the STANAG codes and other new variables was very time- and labor- intensive work for data coders. To facilitate this process, a MS Access data entry form was developed allowing coders to review all relevant data fields, many of which were in free-text format. This data entry form is illustrated in Appendix C. The STANAG cause codes and other new variables developed for this project were also coded using the data entry form.

(2) Data fields from TRAC^{2}ES, DCIPS and ASMIS that were presented in the MS Access data entry form included the following:

(a) TRAC^{2}ES

(i) Social security number, name, age, gender and rank

(ii) For up to 4 movements per evacuation set (less than 5% of cases have more than 4 movements):

- Ready date (when the Soldier is ready for evacuation from given theater)
- Origination and destination theater (e.g., from CENTCOM to EUCOM and then from EUCOM to CONUS)
- Primary, secondary and tertiary diagnosis codes
- Operation (Iraqi Freedom or Enduring Freedom)
- Injury type (battle or non-battle)
- Patient history (free-text)

(b) DCIPS (when linked to TRAC^{2}ES)

(i) Incident date

(ii) Circumstance (free text)

(iii) Diagnosis (free text)

(iv) Cause (free text)

(v) Type of vehicle and occupant status (if MVA)

(c) ASMIS (when linked to TRAC^{2}ES)

(i) Incident date

(ii) Activity

(iii) Description (free text)

(iv) Mission (free text)

(3) New variables developed for this project were incorporated into the MS Access data entry form and were used to code causes of injury and other important details for the injury incident. After reviewing the above listed variables in the data entry form (paragraph 4f(2)), coders then coded the cause of injury and new variables described in Table 4.

Table 4. Description of injury cause coding variables in the MS Access data entry form.

New Fields to Code	Description
Brief history	**Summary of injury cause/circumstance and specifics of diagnosis and injured body part. If illness, description of type.**
STANAG trauma code	**Sub-codes for three classes of trauma for each injury: battle injury (codes 0-1), intentional non-battle injury (codes 2-4) and accidental injury (codes 5-9) (See Table 1)**
STANAG cause code	**A cause code per the NATO Standardization Agreement coding system: STANAG, No. 2050 (See Table 2)**
Pre-existing injury	**Yes/No: Did the injury incident that caused an evacuation occur prior to deployment? If no specific reference was stated in history regarding deployment status at time of injury, it was assumed to have occurred during the present deployment (unless known to have occurred more than a year in the past).**
STANAG trauma code: Pre-existing injuries	**STANAG Trauma code indicating the type of injury sustained prior to deployment (pre-existing) when an evacuee was being evacuated for an exacerbation of a pre-deployment injury. The "regular" trauma code was associated with the incident in theater that aggravated the pre-deployment injury.**
STANAG cause code: Pre-existing injuries	**A cause code for the injury that occurred prior to evacuation. The above "regular" cause code was associated with the incident in theater that aggravated/re-injured the pre-existing.**
Other STANAG cause code	**A "secondary" cause code indicating a supplemental cause of injury. For example, if a Soldier fell playing basketball, the STANAG code would be basketball. This "other STANAG cause code" would be the code for "fall".**
Body part	**The injured body part as selected from a drop-down that included a comprehensive list of single/multiple body parts.**

(4) Coding the STANAG cause code variable (described in Table 4) was performed by using the MS Access data entry form. In addition to the new information coded on the main form, STANAG cause codes were automatically coded by using one of 14 pop-up forms (see Appendix D) accessed by selecting the appropriate command button from the main data entry form (see Appendix C). These pop-up forms covered virtually all possible injury cause codes for this population of air-evacuated Soldiers. The coding of injuries associated with each pop-up form as defined in the STANAG manual is shown below in Table 5.

Table 5. STANAG cause code ranges and STANAG definitions for each pop-up form.

Pop-up form button label	STANAG cause code range [1]	STANAG category descriptions
MVA	**100 to 140** [2]	**Accidents in land transport**
Boarding/Exiting	**103, 113, 123, 133**	
Sports/PT	**220 to 242**	**Athletics and sports accidents, other**
Primary IOW [3]	**440 to 459**	**Conventional weapons injury to person on land or in unspecified location**
Secondary IOW [3]	**460 to 479**	**Indirect or secondary effects of instruments of war, when employed as such in wartime**
Own IOW [3]	**480 to 499**	**Accidents in connection with own instruments of war, when employed as such in wartime**
Own IOW [3,4]	**500 to 599** [5]	**Guns, explosives and related agents, except when used as instruments of war in wartime**
Machinery, tools, etc.	**600 to 699** [5]	**Machinery, tools and selected agents**
Poisons, Fire and Corrosives	**700 to 799** [5]	**Poisons, fire, hot or corrosive substances**
Environmental factors	**800 to 899** [5]	**Specified environmental agents**
Miscellaneous/unknown	**900 to 999** [6,5]	**Falls and miscellaneous other or unspecified agents**
Fall/Jump injuries	**920 to 929** [4,7]	
Twist/Slip/Trip injuries	**940 to 949** [4]	

[1] Missing STANAG code ranges are injury types that rarely occur to Army Soldiers (e.g., aircraft incidents). The "All other codes" pop-up form is used to manually enter a STANAG code not possible with other pop-up forms.
[2] Note that motor vehicle related boarding/exiting injuries have separate pop-up form.
[3] IOW is an abbreviation for "Instrument of war".
[4] For sake of convenience and space issues, this STANAG injury category is also generated via the "Own IOW" pop-up, even though these weapon-based injuries are not necessarily (but nearly always) sustained by ones own weapons (i.e., not enemy weapons).
[5] Third digit represents a place code from 0 to 9 as follows: 1=on aircraft; 2=on ship; 3=on land at dock; 4=on land at industrial plant; 5=on land on firing range; 6=on land on obstacle course; 7=on land in kitchen/mess hall; 8=on land in home or quarters; 9=on land other or unspecified
[6] Note that the miscellaneous fall/jump and twist/slip/trip cause codes have separate pop-up form.
[7] Fall and jump injury cause codes are identical in the STANAG system.

(5) The STANAG cause code for each evacuation case was automatically populated in the data entry form and enhanced database after the coder responded to a series of items in the selected pop-up form. This was achieved by using macros that ran automatically when the coder completed all items in the pop-up forms. The result was that STANAG coding was reliably accomplished without memorizing the correct code (or by the time-consuming process of

referring to the manual). Assuming that the coder began by clicking the correct command button and responded to all items in the pop-up form, the correct STANAG code was generated. This process eliminated errors that would otherwise have arisen if coders 1) selected a "wrong" cause code from the STANAG manual or 2) made errors entering (typing) the selected code into the data entry form. The STANAG manual was, in effect, incorporated into this MS Access interface, thus dramatically reducing the learning curve for a new coder and eliminating mistakes. For the unusual case in which a particular STANAG code was not possible by this method, it could be manually entered within the "All other codes" pop-up form. Table 6 shows the items from each pop-up form that required a coder response in order to auto-populate the correct STANAG code for a given evacuation case. Table 7 shows the additional information (new variables developed for this project) obtained by coder responses to the other items in each pop-up form. Also see Appendix D for the 14 pop-up forms.

Table 6: Fields that auto-populate STANAG cause codes from each pop-up form.

POP-UP FORMS	Complete STANAG cause code [1]	STANAG cause code (no 3rd digit) [2]	Place code of injury [2]	Same/different level of fall/jump and whether from steps/ladder/other	Vehicle ownership and if traffic or non-traffic [3]	Occupant status in vehicle	Type of enemy weapon
MVA					√	√	
Boarding/Exiting					√		
Sports/PT	√						
Primary IOW							√
Secondary IOW	√						
Own weapons[4]	√						
Machinery, tools		√	√				
Poisons/Fire/Corrosives		√	√				
Environmental Factors		√	√				
Miscellaneous/Unknown		√	√				
Jump injuries		√	√	√			
Fall injuries		√	√	√			
Twist/Slip/Trip		√	√				

[1] The 3-digit STANAG cause codes for the injury categories associated with the indicated pop-up forms do not have a 3rd third digit that varies depending on the place of the injury.

[2] The 3-digit STANAG cause codes for the injury categories associated with the indicated pop-up forms have a third digit that varies by place of injury, thus auto-populating the complete STANAG code requires separately asking about cause and place of injury (e.g., in barracks or at air field).

[3] Vehicle ownership refers to military- versus not military-owned, whereas traffic (versus non-traffic) is defined here as either underway or alighting (exiting) a vehicle that will be (was) underway.

[4] This pop-up form includes both "own weapons" when used as instrument of war and injuries sustained by an instrument of war when not being used as such in wartime.

Table 7: Additional fields that provided new information in pop-up forms.

POP-UP FORMS [1]	Vehicle armor	Vehicle type [2]	Crash type	Contributing factors	Injury mechanism	Activity	Fall/ Near-fall status [3]
MVA		√	√	√			
Boarding/Exiting		√		√	√	√	√
Primary IOW	√	√					
Jump injuries		√		√	√	√	
Fall injuries		√		√	√	√	
Twist/Slip/Trip				√	√	√	√

[1] The pop-up forms for Poisons/Fire/Corrosives, Environmental Factors, Sports/PT, Secondary IOW, Own Weapons, and Miscellaneous/Unknown do not have any new fields other than needed to generate the correct STANAG code (see Table 1).

[2] The vehicle type question has an option for "NO VEHICLE NOTED" for the Primary IOW, Jump injuries and Fall injuries pop-up forms.

[3] Twist/Slip/Trip and Boarding/Exiting pop-up forms are injury categories of which a subset may be also classified as "near-fall", thus an additional question is asked that identifies this possibility. Only the Boarding/Exiting pop-up includes an option to code this additional field as a fall.

(6) Several fields were automatically populated in the enhanced air evacuation database dependent on the coder's responses to items in the main data entry form and pop-up forms (back-end data entry). These included:

(a) A '299' STANAG cause code when a 'did the injury occur prior to deployment" question was coded with a '1' for 'yes' on the main form.

(b) A code for injury (versus illness) when any pop-up form was used

(c) A code for falls when the "Fall injuries" pop-up was used

(d) A code for jumps when the "Jump injuries" pop-up was used

(e) A code for vehicle involvement when either the "MVA" or "Boarding/Exiting" pop-up was used.

(f) A field that combined input from several fields to generate a "Type of MVA" field consisting of: collision, rollover, riding (injuries from riding over bumpy/uneven terrain), boarding/exiting, pedestrian, and other specified.

(g) A STANAG cause code for fall/jump or twist/slip/trip in the "other STANAG" field when a "boarding/exiting" pop-up form identified that case as also either a fall/jump or near-fall, respectively.

(7) Automated data entry checks were incorporated into the MS Access interface. Several means of preventing coders from making errors of omission and commission were built into the data entry process. These included:

(a) A macro that ran automatically when advancing to code the next record that:

(i) Checked each required field, dependent on whether the case was coded as in injury or illness, and produced an error message if required data had not been entered.

(ii) Checked to ensure that pre-existing trauma and cause codes were entered when an injury had been coded as having occurred prior to deployment, and prevented advancing to the next case until fixed.

(iii) Checked for incompatible responses in which any injury-only field was used when coded as an illness (and vice versa), producing a relevant error message until fixed.

(iv) Checked the manually entered STANAG trauma codes against the STANAG cause code for inconsistencies, producing an error message if, for example, the trauma code was entered as a battle injury but the cause code reflected a non-battle injury such as a sports-related cause of injury.

(v) Checked, where possible, whether the ICD-9-CM code in TRAC^{2}ES was consistent with the assigned STANAG cause code, and produced a message asking the coder to double-check its accuracy.

(b) A macro that ran automatically when submitting (closing-out) each pop-up form that:

(i) Checked each required field for a response before allowing the form to close.

(ii) Cleared all previously entered new data fields before submitting the current form, thus preventing "bad" data that may have already been entered from some other pop-up form (i.e., if the coder had changed his/her mind about the best STANAG cause code for a given case).

6. RESULTS.

The results of this portion of the deployment injury surveillance project will be described in terms of improvements to the core TRAC^{2}ES data and the improvements in data quality in the enhanced air evacuation database. For the present purposes, data will be used to illustrate these improvements in terms of three criteria often used to evaluate data quality: 1) data utility, 2) data accuracy, and 3) data completeness.

a. **Data Utility.**

(1) An obvious requirement of high quality data is that it has utility, which exists on two independent dimensions.

(a) Firstly, utility as a criterion for high quality data is based on its inherent value to an injury surveillance effort. TRAC^{2}ES data does include detailed information about injuries occurring to deployed Soldiers. The development of the enhanced air evacuation database, as described above, used data from TRAC^{2}ES that was linked to data from DCIPS and ASMIS to create coded data that identifies not only what caused the injury, but also identifies details about

injury mechanism, contributing factors and the activity at the time of the injury incident. For motor vehicle accidents, information about vehicle type, occupant status and type of crash is also coded in the enhanced air evacuation database. When the occupant of a vehicle sustained a battle injury, information about vehicle type, armor and occupant status is also collected. Note, however, that the importance of such detailed injury information for high quality data is diminished if it does not have completeness (i.e., across injuries), which represents an independent criteria of data quality to be discussed later.

(b) Secondly, utility can be considered in the practical sense - "can it be used?". This is necessary no matter how valuable the data is otherwise. To have a high level of utility of this type, a database needs to be 'analysis-ready'. The data quality of the TRAC^{2}ES database was improved in the enhanced air evacuation database by overcoming the following specific obstacles to this type of data utility:

(i) The data structure of the parent TRAC^{2}ES database does not allow person-level analysis. The data quality of the TRAC^{2}ES data is limited by a data structure in which a given Soldier has a record (row) for every executed movement, thus preventing overall analysis based on the 'evacuation set' of a given Soldier (e.g., that often consisted of movements from CENTCOM to EUCOM and then to CONUS). The restructuring of the TRAC^{2}ES data (as described in the "Methods" section) into a horizontal database so that a "case" included all movements within a given 'evacuation set' was the first step to improving its utility. A unit of analysis based on each evacuation (independent of the number of movements) was critical to all subsequent analyses. Restructuring the database in this way also enabled coders to review all information about a given case in a single view on the computer monitor through the MS Access interface.

(ii) Injury cause (and other important) information in TRAC^{2}ES is in a free-text history field. Whereas the TRAC^{2}ES data very often included critical information about the specific cause of a given air-evacuation (with high data quality in the 'valuable' sense), this information only existed in the patient history text field (with low data quality in the 'analysis-ready' sense). The most important way in which the enhanced air evacuation database improved data quality was through our text-mining of the TRAC^{2}ES history field and linked data fields in DCIPS and ASMIS (also free-text) to code all of the new fields described in the Methods section. Appendix E presents the top 10 injury cause categories in OIF through June 2006, which represents the recoded data made possible by the time-intensive process of reading the history narratives for each Soldier.

(iii) ICD-9-CM diagnosis codes in TRAC^{2}ES were not "analysis-ready". The usefulness of the ICD-9-CM codes in TRAC^{2}ES is limited by data formatting that allows for "extra" string data that prevents a straightforward analysis of the numeric codes. All mental health ICD-9-CM codes are, for example, followed by a "-M" or "-F" (e.g., "310.2-F"), presumably to code males versus females. A significant number of the diagnosis codes were also entered with a space between numbers ("529.1 0"). In both cases, string manipulations were required prior to performing analyses. The alphanumeric formatting of the ICD-9-CM fields also allowed entry of data that were not diagnosis codes, and thus not compatible with an analysis based on diagnosis coding. Rather than ICD-9-CM diagnosis codes that identify body part and type of injury, an E-

code (external cause code; "E890") was used in 1,428 cases (for the primary diagnosis code associated with the movement out of OIF or OEF). Ninety percent of the cases that had an E-code instead of a diagnosis code were STANAG-coded as a battle injury (28% of all battle injuries), and appeared primarily beginning in April of 2004. "V" procedures codes (e.g., "V13.01") were also used in 736 cases, of which 83% were STANAG-coded as illnesses (4% of all illnesses).

(2) In addition to the above problems with the data utility of TRAC^{2}ES data, which were overcome in the development of enhanced air evacuation database, the utility of the enhanced database was also improved by two modifications of the STANAG coding system that otherwise limited its inherent epidemiologic value to injury surveillance (i.e., the first dimension of data utility). Each is described below:

(a) Jumps and falls have the same STANAG cause code. The utility of the STANAG coding system is limited by a STANAG cause code that (1) combines falls and jumps and (2) combines falls/jumps that occur "on the same level" with those that are unspecified in this regard (i.e., versus "from one level to another"). Instead, in the enhanced coded air evacuation database, new fields were created that (1) coded falls separately from jumps and (2) coded type of fall/jump while differentiating between specified and unspecified type of falls and jumps. The result was an improved understanding of injuries caused by falls and jumps, while also uncovering how many falls and jumps actually had an unspecified type (versus occurring "on the same level"). This information is especially important because the falls/jumps injury cause category (as coded in the STANAG system) was the number one and two reasons for an air-evacuations from OIF and OEF, respectively, from the beginning of these operations through June 2006.

(b) STANAG cause codes for pre-deployment (pre-existing) injuries are blind to its actual cause. One type of injury in which the STANAG cause coding system is less useful occurs when the cause of an evacuation is actually the result of the late (or worsening) effects of an injury that occurred prior to deployment. In the STANAG system, a late effects code is the only option, without the ability to capture the cause of that original pre-deployment injury. To overcome this problem with utility (and thus increase data quality), two changes were made to the intent of the STANAG cause coding system, as follows:

(i) A "real" cause code was assigned if the original injury occurred during the Soldier's present deployment. If the time period since injury was known without reference to deployment status, a 1-year cutoff was used to base an assumption that the injury occurred prior to deployment. If no information was available regarding how much time had passed since the injury, it was assumed to have occurred during the present deployment.

(ii) For injuries that occurred prior to deployment, two STANAG cause codes were used to identify, firstly what caused the original symptoms to reappear or worsen during the deployment and secondly, what caused the pre-deployment injury. The former resulting cause code was used in primary analyses of all injuries occurring in theater.

(3) Two other requirements for data to have utility are accessibility and timeliness. Each of these requirements increases the utility of the data in important ways and are inherent in the TRAC^{2}ES database. The benefits of each to utility are:

(a) Accessibility relates to the ability of the data to be easily obtained by those with a need to know. A streamlined means of accessing a given data set encourages greater use by decision-makers, commanders, preventive medicine/military public health leaders, researchers and others. The TRAC^{2}ES database can be, with proper permissions, downloaded on request.

(b) Timeliness relates to the ability of the data to determine current injury rates and to detect emerging problems. Data also needs to be timely enough to use to set priorities and focus attention on injury problems as they currently exist. The present injury surveillance project is the first-ever opportunity to study the epidemiology of non-battle and battle injuries during an on-going conflict. Downloads of the TRAC^{2}ES database are current, including evacuation data that is provided on a near real-time basis.

b. **Data Accuracy.**

(1) Another important criterion for high quality data is accuracy. Data can be "bad" for two general reasons: 1) data entry errors of otherwise accurate information and 2) data that is correctly entered but is inherently wrong (i.e., misinformation). With two exceptions as discussed below, these threats to quality data in the TRAC^{2}ES database are minimal. Although key TRAC^{2}ES data that exists only in an uncoded patient history field has low utility as discussed above, it is relatively accurate since simple typing errors do not prevent an ability to decipher the information. In addition, because data entry is conducted by medical personnel close to a given Soldier's treatment, misinformation also seems unlikely. In addition, the linkage of cases with DCIPS and ASMIS records (where possible) provided an important opportunity to validate and improve the accuracy of data in the enhanced air evacuation database. Typically, these other linked databases supplemented what was known from TRAC^{2}ES alone to provide a more complete picture of what happened to cause an injury. The infrequent conflict between TRAC^{2}ES and the other databases was resolved on a case-by-case basis depending on which source seemed to have the most detailed account of what happened.

(2) "Reason for evacuation" information in TRAC^{2}ES data is not reliable/accurate. Information that identifies the reason for an evacuation (battle injury, non-battle injury, or disease) is recorded in TRAC^{2}ES for each movement of a given evacuation set (e.g., from CENTCOM to EUCOM, and then from EUCOM to CONUS). This information is obtained by a combination of two fields: (1) a field coded to differentiate battle injuries from other reasons (non-battle injury and disease combined) and (2) a field that then separately codes battle and non-battle injuries. This information has proven to be somewhat unreliable. Not only does it not always agree from one movement to the next, but in 5% of battle injuries and 10% of non-battle injuries, it was incorrect as judged by the coders as the cases were reviewed for this project. By reviewing each history field (for each movement and linked information in DCIPS/ASMIS), more accurate codes for injury (battle or non-battle) and "illness or other medical condition" were entered by coders. This improved accuracy for the reason for evacuation represents an important enhancement of the injury surveillance data.

(3) Data accuracy for new coded fields is assured by several means in the enhanced air evacuation database.

(a) Keystroke errors are virtually eliminated by the "mouse-driven" nature of data entry. Coding simply involves the selection of the appropriate item from a drop-down or list box (see Appendices C and D).

(b) Secondly, selecting an inappropriate response (i.e., creating misinformation) is prevented in three ways:

(i) Forcing a response from a drop-down list increases accuracy by reminding the coder of all eligible choices, including those that are needed only rarely.

(ii) Auto-populating the STANAG cause code based on selecting the appropriate pop-up form and answering the resulting questions prevents human error by providing the correct decision tree to follow and eliminating the potential for a recall (or keystroke) error when manually entering codes.

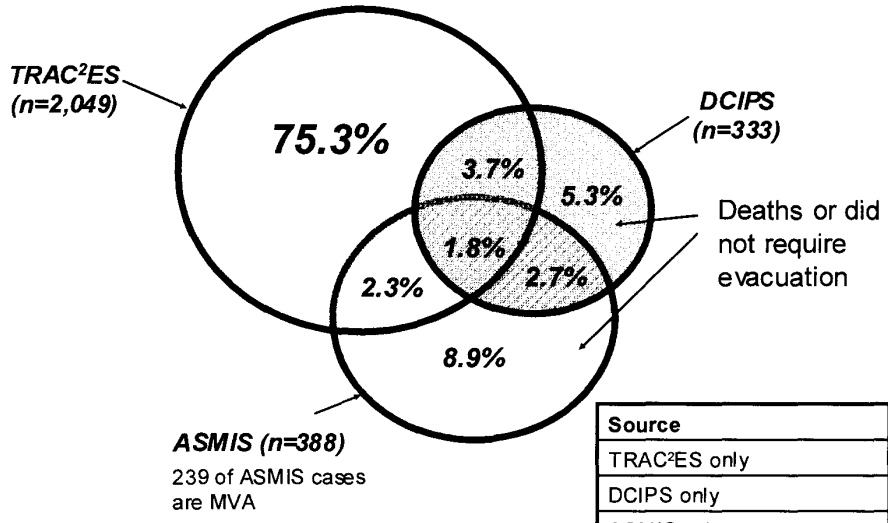
(iii) When possible, data entered for a given case is automatically checked (validated) for accuracy. The coder is automatically alerted of problems that must be fixed before proceeding. For example, if the selected Trauma code (STANAG) is "0" (direct result of action by or against enemy) and the STANAG cause of injury code is basketball, the coder would be notified of an error since sports-related injuries are not "battle injuries".

c. **Data Completeness.**

(1) Completeness as a criterion for high quality data for injury surveillance has two components:

(a) Firstly, a database needs to, ideally, have 100% case ascertainment, capturing every case that meets the case definition for inclusion. TRANSCOM routinely and systematically collects information about each Soldier who is air-evacuated from any location around the world. The resulting TRAC^{2}ES database then has near 100% case ascertainment. As described in the Methods section above, the present injury surveillance initiative is defined as including all active duty Soldiers air-evacuated from OIF and OEF.

(i) Figure 1 highlights the superiority of TRAC^{2}ES in terms of its near 100% case ascertainment, by contrasting the non-battle injuries captured in TRAC^{2}ES to the same captured in DCIPS and ASMIS (during the first nine months of 2004). Of all cases captured between these three databases (n=2466), three-quarters were only in the TRAC^{2}ES database. This is remarkable given that TRAC^{2}ES actually represents the smallest population (i.e., only Soldiers air-evacuated from CENTCOM). Because TRAC^{2}ES included virtually every non-battle injury air-evacuated from CENTCOM, the lack of case ascertainment in DCIPS and ASMIS become very apparent.



Source	N	%
TRAC²ES only	1,856	75.3
DCIPS only	130	5.3
ASMIS only	220	8.9
TRAC²ES + DCIPS only	92	3.7
TRAC²ES + ASMIS only	57	2.3
DCIPS + ASMIS only	67	2.7
TRAC²ES, DCIPS + ASMIS	44	1.8
TOTAL	**2,466**	**100**

Figure 1. Non-battle injuries found in TRAC^{2}ES, DCIPS and ASMIS: Jan-Sept, 2004

(b) Secondly, the data must be adequate and accurate for each case with data. Important to this process of maximizing data completeness in the enhanced air evacuation database was the ability to "fill in" missing information in TRAC^{2}ES with data from linked cases in DCIPS and ASMIS. Typically these other linked databases supplemented what was already known from TRAC^{2}ES, providing a more complete picture of what happened to cause an injury.

(2) Even in the enhanced air evacuation database, however, there were several potential threats to data completeness. These included:

(a) Lack of specific cause of injury information to allow selection of a specific STANAG cause code.

(i) The strength of TRAC^{2}ES is that it is the only database that contains injury cause information for all Soldiers who were air-evacuated for injuries, but this information is noted "only" in the free-text patient history field (and in history fields from linked DCIPS/ASMIS databases). The enhanced air evacuation database included the creation of a STANAG cause code for as many cases as possible. Whereas less than 0.05% of battle injuries had an unknown cause, injury cause was unknown for 35% of non-battle injuries (for OEF and OIF, combined, from the beginning of each operation through June 2006). However, the reason for this lack of

cause information was often due to musculoskeletal complaints that could not be traced to a single acute event (e.g., an overuse injury), thus reducing the threat to data quality.

(ii) It is also interesting to note that many missing causes occurred when the musculoskeletal complaints in theater could be traced to an injury that had occurred prior to deployment. When excluding these cases in which symptoms reappear (or worsen) during deployment, the proportion of missing cause information is reduced to 25%. In addition, because the back, shoulder, and knee were more likely to have an unknown injury cause (57%, 48%, and 39% of unknown causes, respectively) and represented the 1st, 4th and 2nd most common anatomic locations, respectively, nearly 60% of all unknown injury causes were associated with these three anatomic locations.

(b) Lack of distinction in the STANAG cause code scheme between falls and jumps. As discussed above, a problem was cited with the utility of the STANAG cause code that (1) combines falls and jumps and (2) combines falls/jumps "on the same level" with "unspecified falls/jumps". In the enhanced air evacuation database, new fields were created that coded falls separately from jumps and created a unique code for the situation in which the type of fall or jump was unspecified. The degree of completeness regarding this latter information could then be determined separately for falls and jumps. Indeed, the percentage that were found not to specify whether it occurred "from one level to another" or "on the same level" was higher for falls than jumps (37% and 9%, respectively). At the same time, it is possible that a bias existed to code jumps (but not falls) as "one level to another" even without a specific mention of jumping from a height, thus accounting for the low percentage of jumps (compared to falls) that were coded as unspecified. Interestingly, the STANAG coding scheme ignores the possibility that jumps could be unspecified in this regard, describing this code as "Falls or jumps on the same level, including unspecified falls" (page A-I-16).[8]

(c) Lack of detail in the STANAG coding scheme for motor vehicle-related incidents. The STANAG cause codes for motor vehicle-related accidents incorporates potentially important information by requiring a different code for each person injured (driver, passenger, pedestrian), for boarding and alighting from a vehicle, and for wheeled vehicle versus tracked vehicle. However, the review of TRAC^{2}ES patient histories (and information from linked DCIPS/ASMIS cases) did not find this occupant-related information in 60% of all motor vehicle accidents.

(d) Lack of completeness in the ICD-9-CM diagnosis codes in TRAC^{2}ES that were used to classify injury types. Thirty- three percent of battle injury cases and 4% of non-battle injury cases had no primary diagnosis code. For battle injuries, 84% of the 1,522 missing codes actually occurred when an E-code was used rather than a diagnosis code, whereas the same was the case for 36% of the 405 missing non-battle diagnosis codes. V-codes were also observed to be used in place of a diagnosis code, covering 4% and 16% of missing codes for battle and non-battle injuries, respectively. Interestingly, missing ICD-9-CM diagnosis codes that were simply missing occurred for only 6% of battle injuries and 2% of non-battle injuries. Whereas E-codes and V-codes are also sometimes used in place of the diagnosis codes in civilian databases (and provide useful information), no meaningful analyses are possible that includes these extraneous codes when added to a field intended for diagnosis codes (i.e., rather than in a separate field for each).

(e) Resulting lack of completeness of new fields in the enhanced air evacuation database. As discussed above, one component of utility as a criterion of high quality data is based on its inherent value to an injury surveillance effort, which is enhanced by inclusion of not only what happened (to cause an injury), but also, additional information about how the injury occurred. The development of the enhanced air evacuation database included an effort to further explore patient histories for more possible details, which was carried out for falls, near-falls, jumps, motor vehicle accidents, and battle injuries that occurred to a vehicle occupant (e.g., caused by an IED). Because the usefulness of this more detailed information is diminished if it does not have completeness (i.e., across injury incidents), this criterion for high quality data is addressed below for each of these new fields in enhanced database:

(i) Anatomic location of injury: Not missing for any of the non-battle injuries, but unspecified for 4 of the battle injuries (0.1%).

(ii) Activity at time of injury

- Unspecified for 30% of jump injuries
- Unspecified for 56% of fall injuries
- Unspecified for 50% of near-fall injuries

(iii) Injury mechanism

- Unspecified for jumps (other than "landing on surface")
- Unspecified for 80% of falls
- Unspecified for 23% of near-falls

(iv) Contributing factors

- Unspecified for 90% for jumps
- Unspecified for 86% of falls
- Unspecified for 75% of near-falls

(v) Vehicle type: Jumps and falls

- Unspecified for 14% of jumps
- Unspecified for 13% of falls

(vi) Motor vehicle accidents

- Vehicle type unspecified for 38% of MVAs

- Crash type unspecified for 28% of MVAs
- Occupant status unspecified for 60% of MVAs

(vii) Vehicle occupant injured by instrument of war

- Vehicle type unspecified for 30% of these cases
- Vehicle armor unspecified for 48% of these
- Occupant status unspecified for 29% of these cases

(viii) STANAG cause codes for injuries that occurred prior to deployment were unspecified for 80% of evacuations caused by pre-deployment injury.

(f) It is clear that even when TRAC^{2}ES is supplemented with DCIPS and ASMIS, it still has some limitations in the degree to which one can "drill down" to greater detail about the above injury cases. Whereas it was expected that the anatomic location of injury would have data for virtually all cases, information that would have provided a better understanding of injury circumstance (contributing factors, injury mechanism and activity) was too incomplete to be useful. Despite near-falls, which were consistently more complete with this important data, other sources of information that provide more detailed information are needed (or a change in the detail provided in TRAC^{2}ES).

(g) As also shown above, a specific STANAG cause code was possible in only 20% of injuries that occurred prior to deployment (but was the reason for an evacuation from theater). Given that 16% of non-battle injuries evacuated from CENTCOM have been this type, the availability of the cause of these "old" injuries would provide important information about which types of injuries are more likely to cause a serious problem once deployed.

(h) Finally, though vehicle-involved data were more often available for coding in the enhanced air evacuation database, its epidemiologic value is limited. It is, however, interesting that vehicle-involved battle injuries had the most complete information on vehicle type and occupant status. This result demonstrates the value of linkage with DCIPS, which (1) already has fields that identify vehicle type and occupant status and (2) includes all battle injuries.

7. CONCLUSION.

The enhanced air evacuation database developed for this project has high quality data and is analysis-ready. Significant time and effort were required to improve the primary three elements of data quality (utility, accuracy, and completeness). The inclusion of coded causes of injury represents an important and dramatic improvement compared to the parent TRAC^{2}ES air evacuation data. This enhanced database has demonstrated its overall utility in the current OEF and OIF deployments, being the only source for coded causes of injury.

The enhanced air evacuation database can be argued to have a high level of data quality not seen in any other data source, which includes information on virtually every Soldier evacuated due to non-battle and battle injury. Whereas TRAC^{2}ES contains highly accurate and valuable information for this injury surveillance initiative, it is primarily dependent on the free-text patient history fields. The development of the enhanced database, however, overcame this obstacle to utility with the time-intensive process of establishing STANAG injury cause codes for injury-related air evacuation. Undeniably, the key enhancement to the TRAC^{2}ES database may be this dramatic increase in data utility achieved by providing cause codes.

The process of the text mining the free-text patient history fields in TRAC^{2}ES also revealed a limit to how much additional detail is possible. After examining the information available in linked cases from DCIPS and ASMIS, cause information was possible in only 65% of injury evacuations from OIF and OEF (and 75% when excluding the deployment-related "late effect" of pre-deployment injuries). The attempt in the enhanced database to drill-down to more detail on the circumstances associated with falls, near-falls, jumps, and motor vehicle accidents revealed a true lack of information that was available but unspecified in TRAC^{2}ES. In addition, approximately 25% battle injuries had no assigned diagnosis code.

To reliably prevent injuries, knowledge of the causes of injuries is essential. Thus, the primary benefit derived from this enhanced deployment injury surveillance database is readily accessible coded injury types and causes of injury for air evacuated injury cases. With the accessibility and timeliness of the TRAC^{2}ES database, the enhanced air evacuation database represents a high quality database that has great potential value for large-scale deployment injury surveillance.

8. POINT OF CONTACT.

Refer questions pertaining to this report to Keith G. Hauret, Project Manager, Injury Prevention Program, Directorate of Epidemiology and Disease Surveillance, at (410) 436-5291, DSN 584-5291, or email to keith.hauret@us.army.mil

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Injury Epidemiologist
Injury Prevention Program

Approved:

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Manager
Injury Prevention Program

Appendix A
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Appendix B

DEPARTMENT OF THE ARMY
OFFICE OF THE ASSISTANT SECRETARY OF THE ARMY
INSTALLATIONS AND ENVIRONMENT
110 ARMY PENTAGON
WASHINGTON DC 20310-0110

MAY 0 2 2005

MEMORANDUM FOR COMMANDER, US ARMY MEDICAL COMMAND/THE SURGEON GENERAL, 5109 LEESBURG PIKE, FALLS CHURCH, VA 22041 (ATTN: MS. SIL FINAMORE, DASG-ZXA)

SUBJECT: Request for USACHPPM Analyses of CENTCOM AOR Non-Battle Injuries

1. Non-battle injuries have been a major cause of morbidity and mortality during past combat operations. Preliminary analysis using medical evacuation data (TRAC2ES) in January 2004 by the US Army Center for Health Promotion and Preventive Medicine (USACHPPM) showed that non-battle injuries accounted for 39% of air evacuations from the CENTCOM AOR for Operations Iraqi Freedom (OIF) and Enduring Freedom (OEF). Many injuries within the three leading causes of non-battle injuries (falls, motor vehicle-related mishaps, and sports/physical training) may be preventable.

2. I request the assistance of the USACHPPM to provide on-going analyses of non-battle injuries that require air evacuation from the CENTCOM AOR and to identify potentially preventable causes of non-battle injuries. Specifically, it is requested that the USACHPPM identify and link medical, safety, and personnel data sources that document battle injuries, non-battle injuries, and diseases during deployments, such as OIF and OEF to:

a. Describe the distribution of diagnoses (ICD-9 codes) for Soldiers hospitalized in, or air evacuated from, the CENTCOM AOR.

b. Describe the relative impact and rates of non-battle injuries compared to battle-injuries and to other medical conditions and illnesses that required air evacuation, hospitalization, or other health care.

c. Identify causes of NBI that may be preventable.

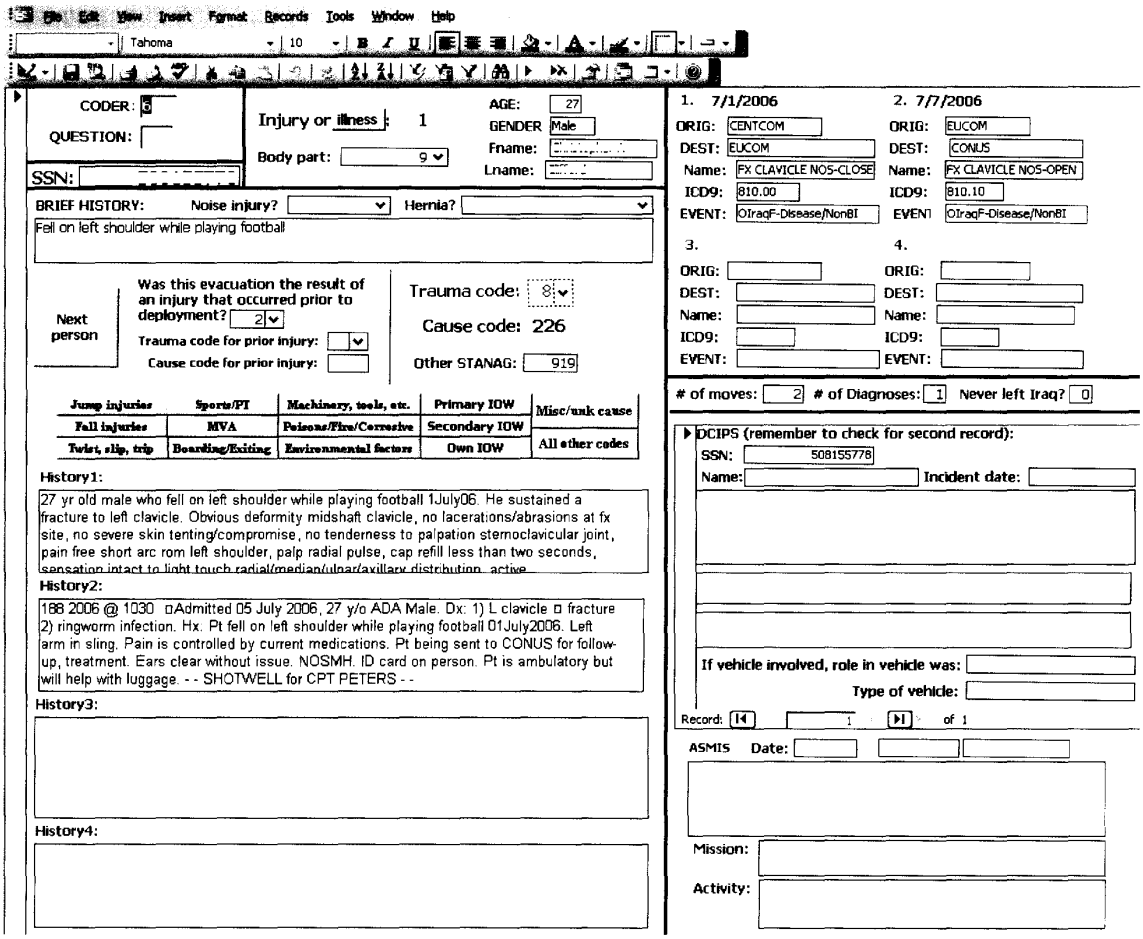
d. Validate the diagnoses and causes of injuries from the medical evacuation data against other medical and safety data sources.

3. I thank you for your assistance with this. I am confident that this analysis will provide the Army with critical information for reducing Soldier injuries and enhancing readiness, combat effectiveness, well-being and morale. My point of contact is Mr. Jim Patton, 703-697-3123.

Raymond J. Fatz
Deputy Assistant Secretary of the Army
(Environment, Safety and Occupational Health)
OASA(I&E)

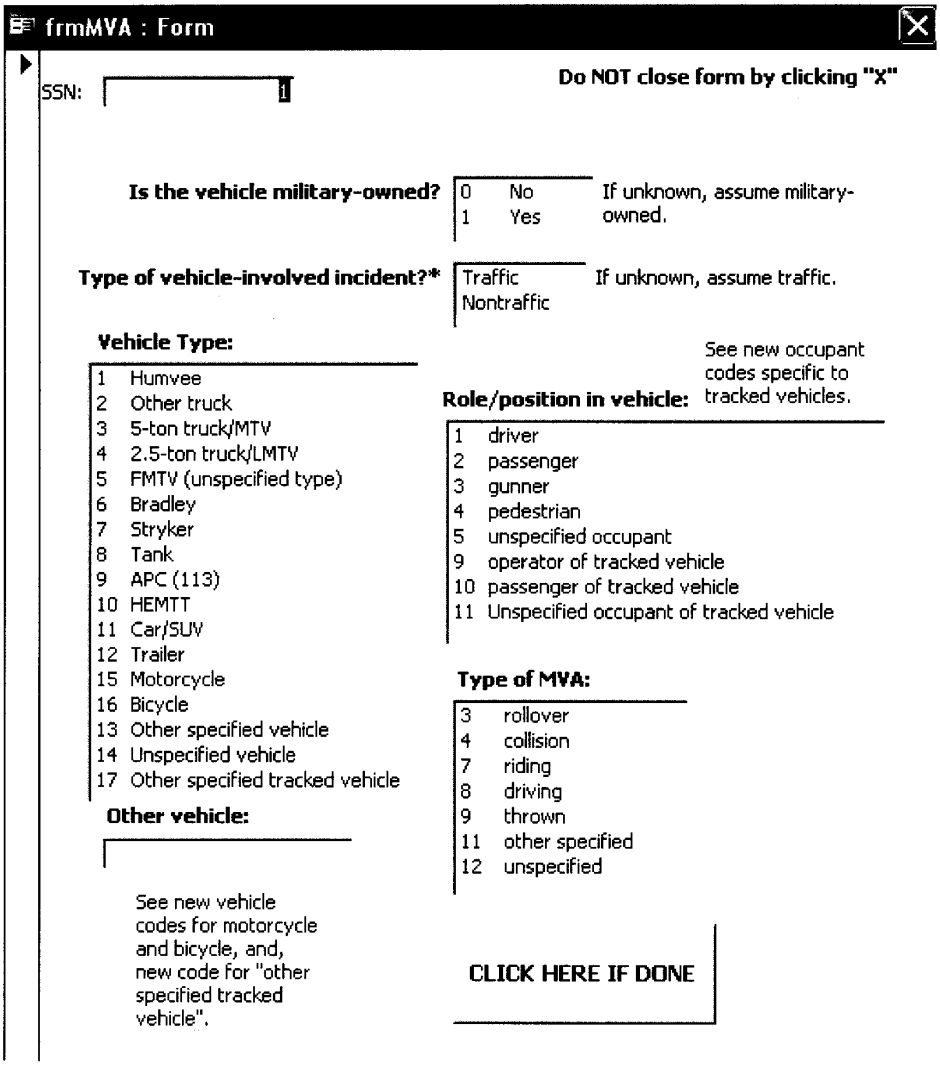
Printed on Recycled Paper

Appendix C
Main Data Entry Form

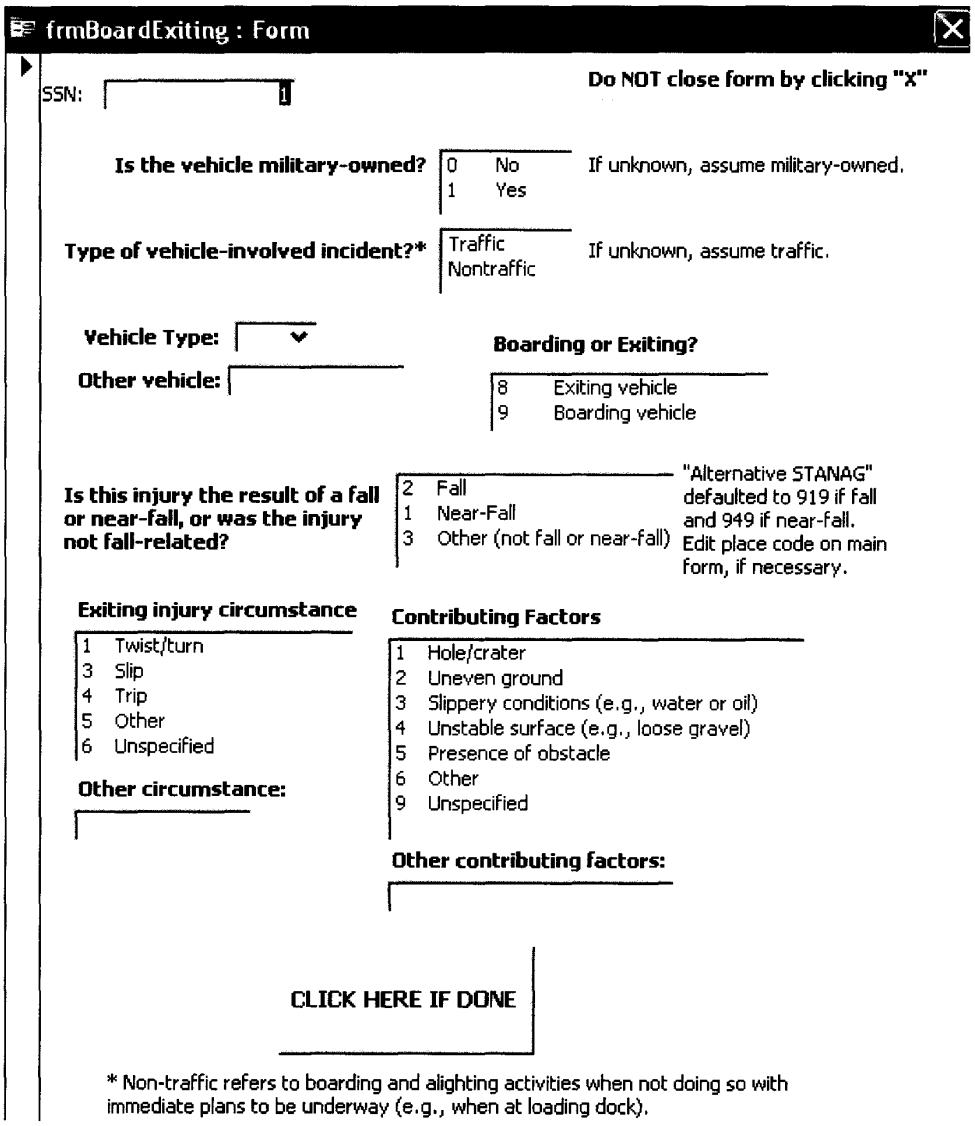


Appendix D
14 POP-UP FORMS

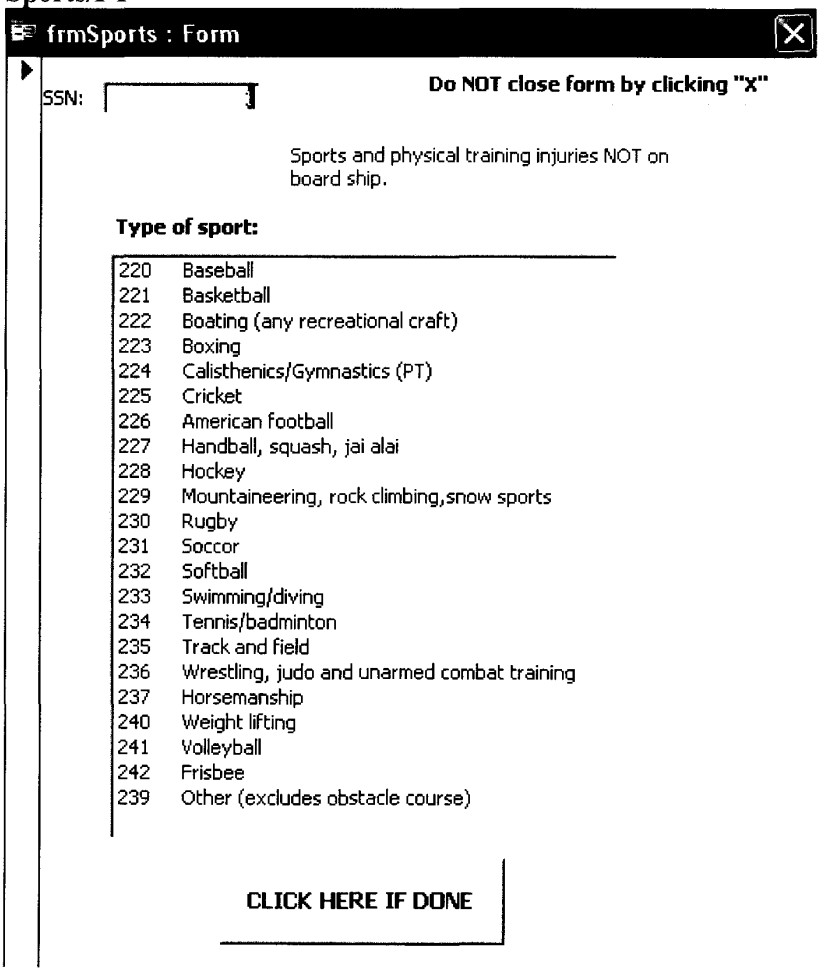
MVA POP-UP



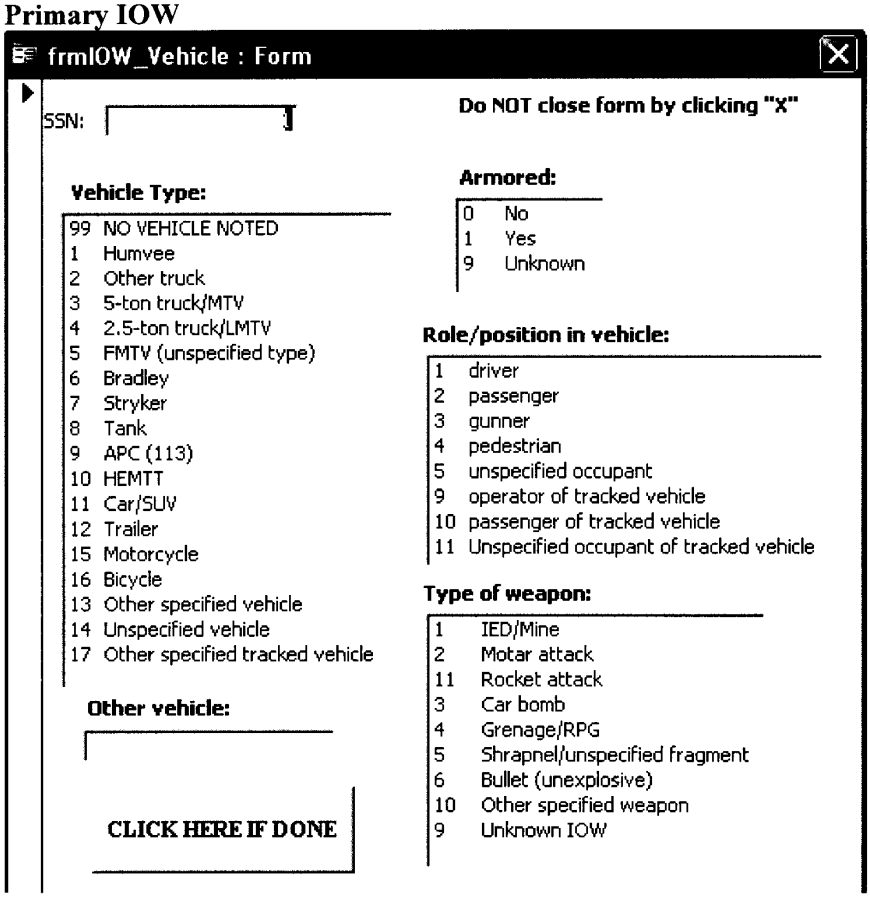
Boarding/Exiting



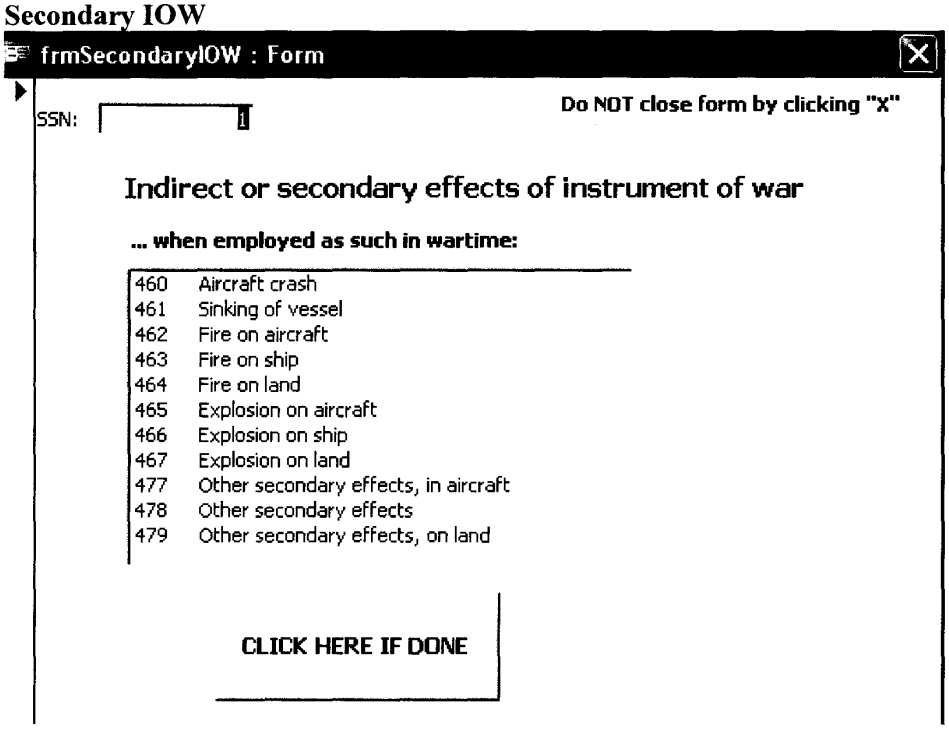
Sports/PT


frmSports : Form
SSN:
Do NOT close form by clicking "X"
Sports and physical training injuries NOT on board ship.
Type of sport:
220 Baseball
221 Basketball
222 Boating (any recreational craft)
223 Boxing
224 Calisthenics/Gymnastics (PT)
225 Cricket
226 American football
227 Handball, squash, jai alai
228 Hockey
229 Mountaineering, rock climbing,snow sports
230 Rugby
231 Soccor
232 Softball
233 Swimming/diving
234 Tennis/badminton
235 Track and field
236 Wrestling, judo and unarmed combat training
237 Horsemanship
240 Weight lifting
241 Volleyball
242 Frisbee
239 Other (excludes obstacle course)
CLICK HERE IF DONE

Primary IOW


frmIOW_Vehicle : Form
SSN:
Do NOT close form by clicking "X"
Vehicle Type:
99 NO VEHICLE NOTED
1 Humvee
2 Other truck
3 5-ton truck/MTV
4 2.5-ton truck/LMTV
5 FMTV (unspecified type)
6 Bradley
7 Stryker
8 Tank
9 APC (113)
10 HEMTT
11 Car/SUV
12 Trailer
15 Motorcycle
16 Bicycle
13 Other specified vehicle
14 Unspecified vehicle
17 Other specified tracked vehicle
Other vehicle:
CLICK HERE IF DONE
Armored:
0 No
1 Yes
9 Unknown
Role/position in vehicle:
1 driver
2 passenger
3 gunner
4 pedestrian
5 unspecified occupant
9 operator of tracked vehicle
10 passenger of tracked vehicle
11 Unspecified occupant of tracked vehicle
Type of weapon:
1 IED/Mine
2 Motar attack
11 Rocket attack
3 Car bomb
4 Grenage/RPG
5 Shrapnel/unspecified fragment
6 Bullet (unexplosive)
10 Other specified weapon
9 Unknown IOW

Secondary IOW



Own IOW

frmOwnWeapons : Form

SSN:

Do NOT close form by clicking "X"

Choose only one code from one of the two lists below. The place of injury code is only required if a 500 to 590 code is needed.

Accidents in connection with own instruments of war, when employed as such in wartime:

480	Own nuclear weapons
481	Own chemical warfare agents
486	Own rockets, missiles, etc.
487	Launching mechanisms of own rockets, missiles, etc.
488	Own bombs, artillery, etc.
489	Mechanisms of own artillery, bomb-bays, etc.
490	Own mines, torpedos, booby traps, grenades, etc.
491	Own small arms fire, INCLUDES FRIENDLY FIRE
492	Explosion of own munitions, in conneciton with handling, storage, etc.
493	Explosion of own weapons
494	Effects of discharge (noise, pressure, etc.) of own weapons
495	Mechanisms of own small arms weapon
496	Other injury in handling of own weaons or munition (exludes explosion)
499	Unspecified injury from own instruments of war

Own guns, explosives and related agents, BUT NOT when employed as such in wartime (includes accidental exposure from the enemy, if known not to be intended as an instrument of war):

500	Nuclear weapons
510	Chemical warfare agents
520	Biological warfare agents
530	Rockets and missiles (including launching mechansims)
540	Bombs, artillery and other projectiles
550	Mines (land or sea, torpedos, grenades, etc.)
560	Bullets from small arms weapons (INCLUDING SELF-INFLICTED)
570	Explosion in the handling of ammunition/munitions
580	Mechanism of small arms weapon
590	Other or unspecified gun, explosive or related agent

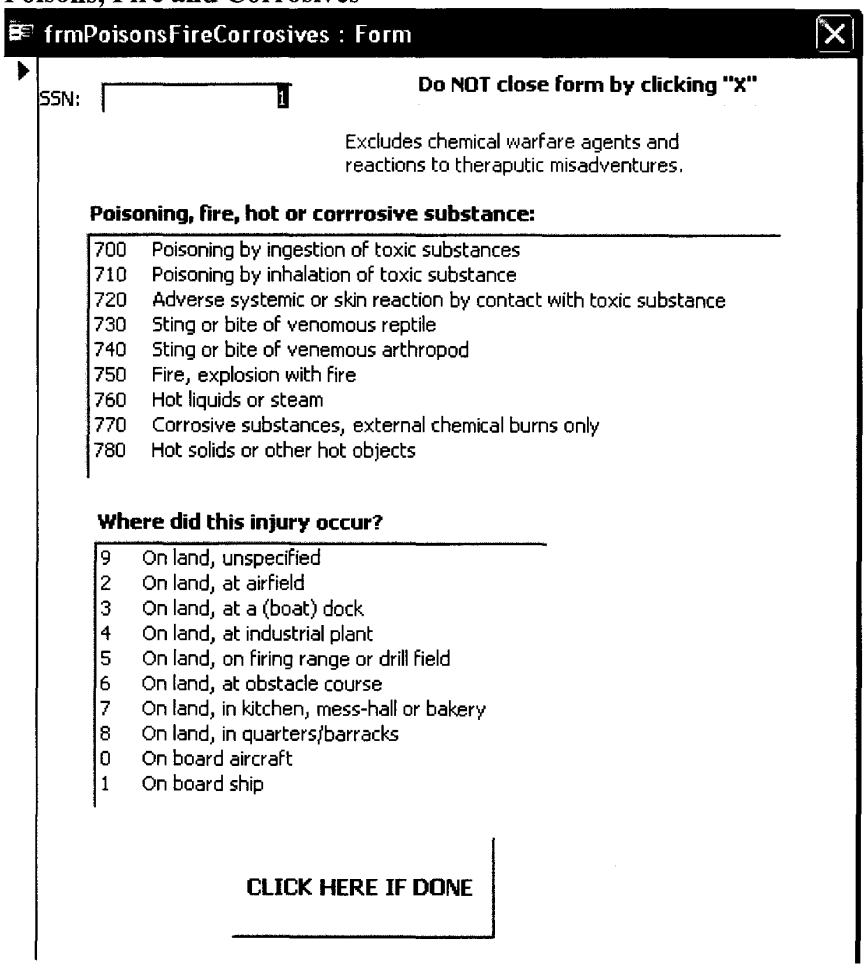
Where did this injury occur (only needed with above 500 series)?

9	On land, unspecified
2	On land, at airfield
3	On land, at a (boat) dock
4	On land, at industrial plant
5	On land, on firing range or drill field
6	On land, at obstacle course
7	On land, in kitchen, mess-hall or bakery
8	On land, in quarters/barracks
0	On board aircraft
1	On board ship

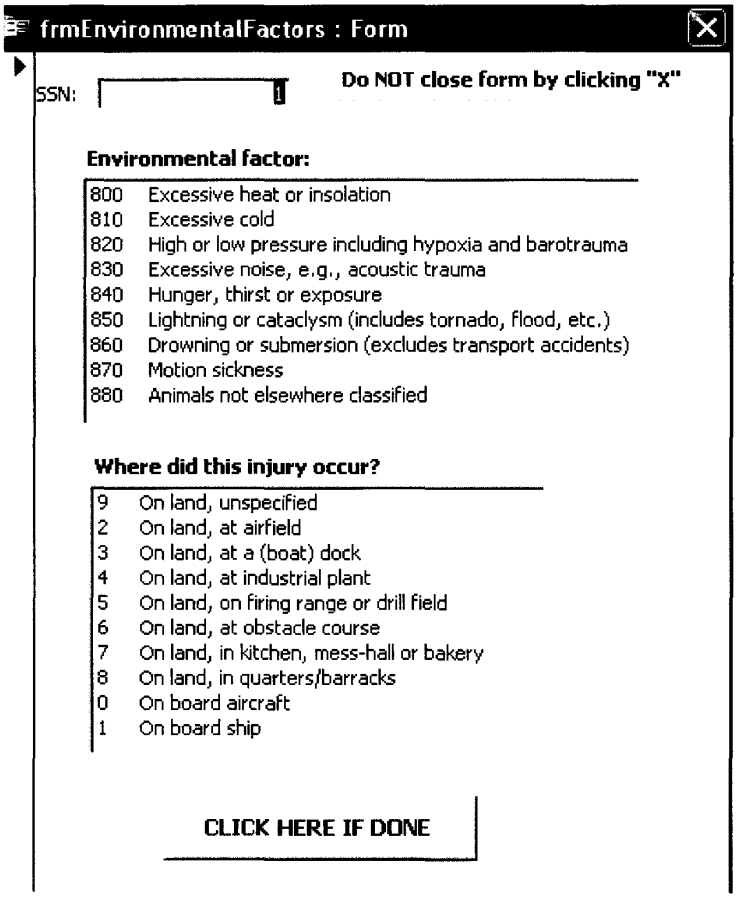
CLICK HERE IF DONE

Clear this form

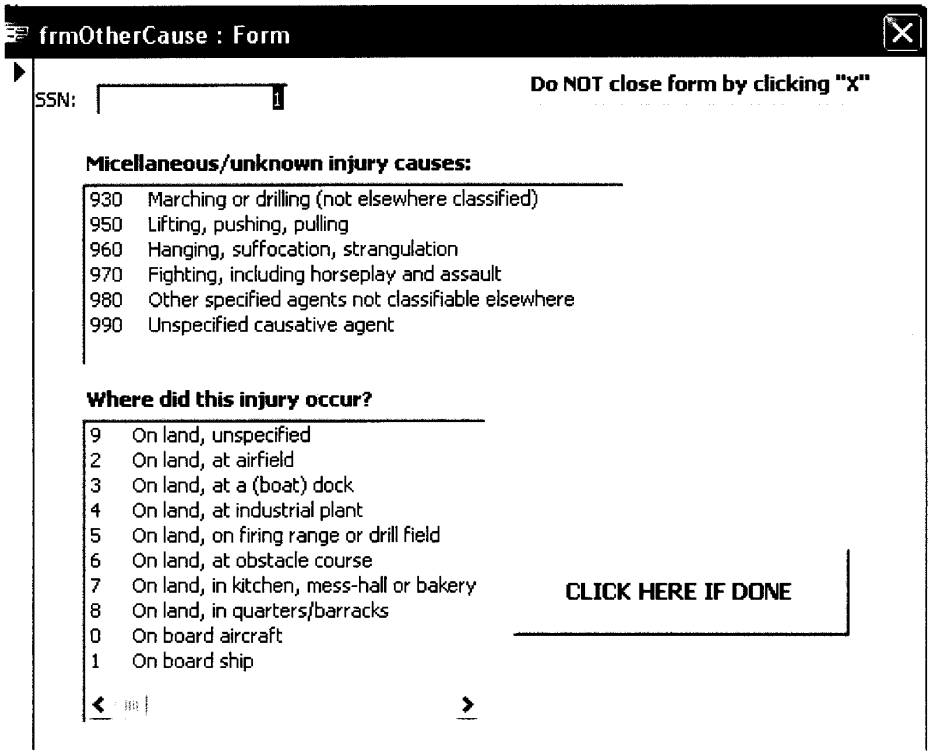
Poisons, Fire and Corrosives



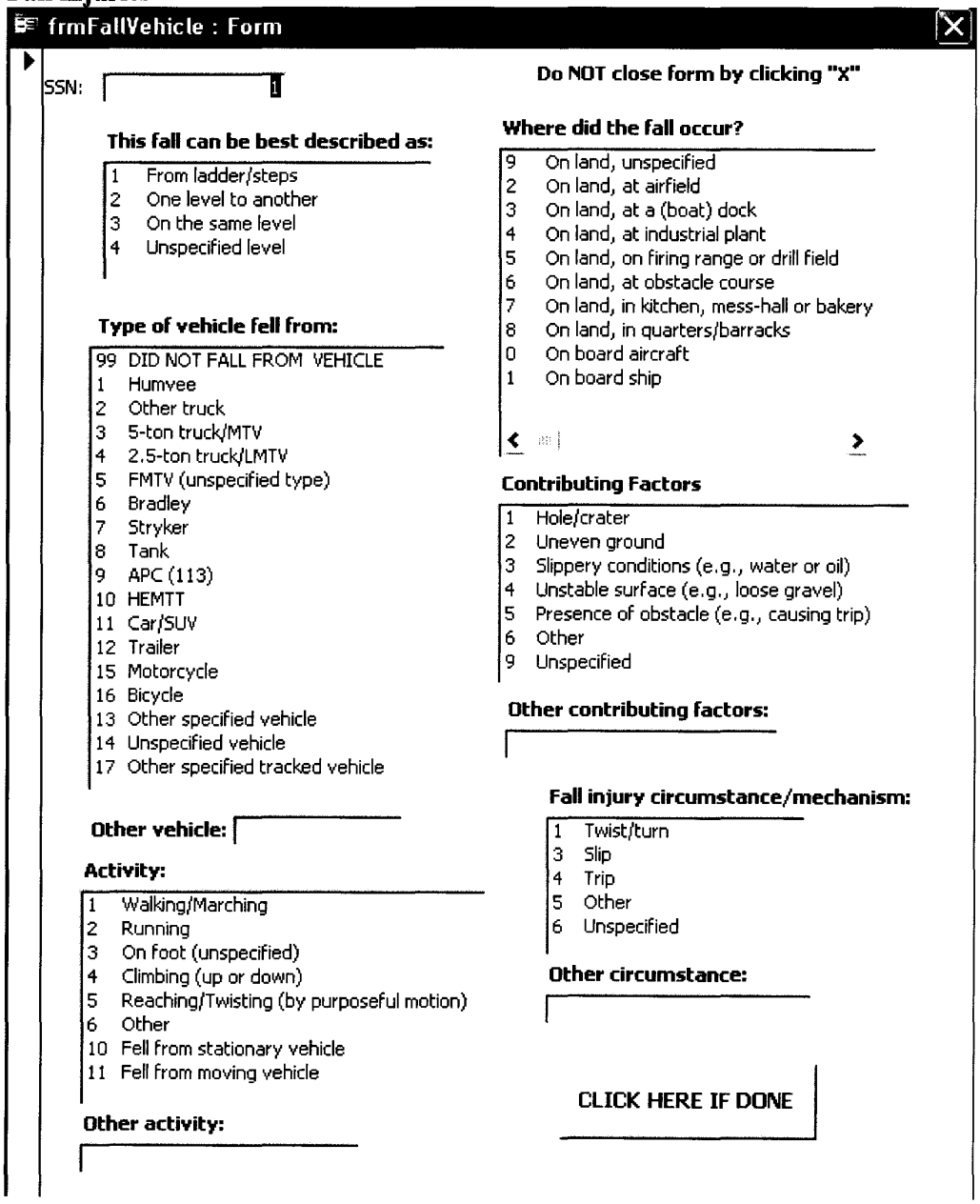
Environmental factors



Miscellaneous/unknown



Fall injuries



Jump injuries

frmJumpVehicle : Form

SSN:

Do NOT close form by clicking "X"

Where did this jump occur?

9	On land, unspecified
2	On land, at airfield
3	On land, at a (boat) dock
4	On land, at industrial plant
5	On land, on firing range or drill field
6	On land, at obstacle course
7	On land, in kitchen, mess-hall or bakery
8	On land, in quarters/barracks
0	On board aircraft
1	On board ship

Type of vehicle jumped from:

99	DID NOT JUMP FROM VEHICLE
1	Humvee
2	Other truck
3	5-ton truck/MTV
4	2.5-ton truck/LMTV
5	FMTV (unspecified type)
6	Bradley
7	Stryker
8	Tank
9	APC (113)
10	HEMTT
11	Car/SUV
12	Trailer
15	Motorcycle
16	Bicycle
13	Other specified vehicle
14	Unspecified vehicle
17	Other specified tracked vehicle

Other vehicle:

This jump is best descri bed as:

1	From steps/ladder
2	One level to another
3	On the same level (within vehicle)
4	Unspecified level

Contributing factors:

1	Hole/crater
2	Uneven ground
3	Slippery conditions (e.g., water or oil)
4	Unstable surface (e.g., loose gravel)
6	Other
9	Unspecified

Other contributing factors:

Injury cirucumstance/mechanism:

2	Landing on surface (default choice)
5	Other

Other circumstance:

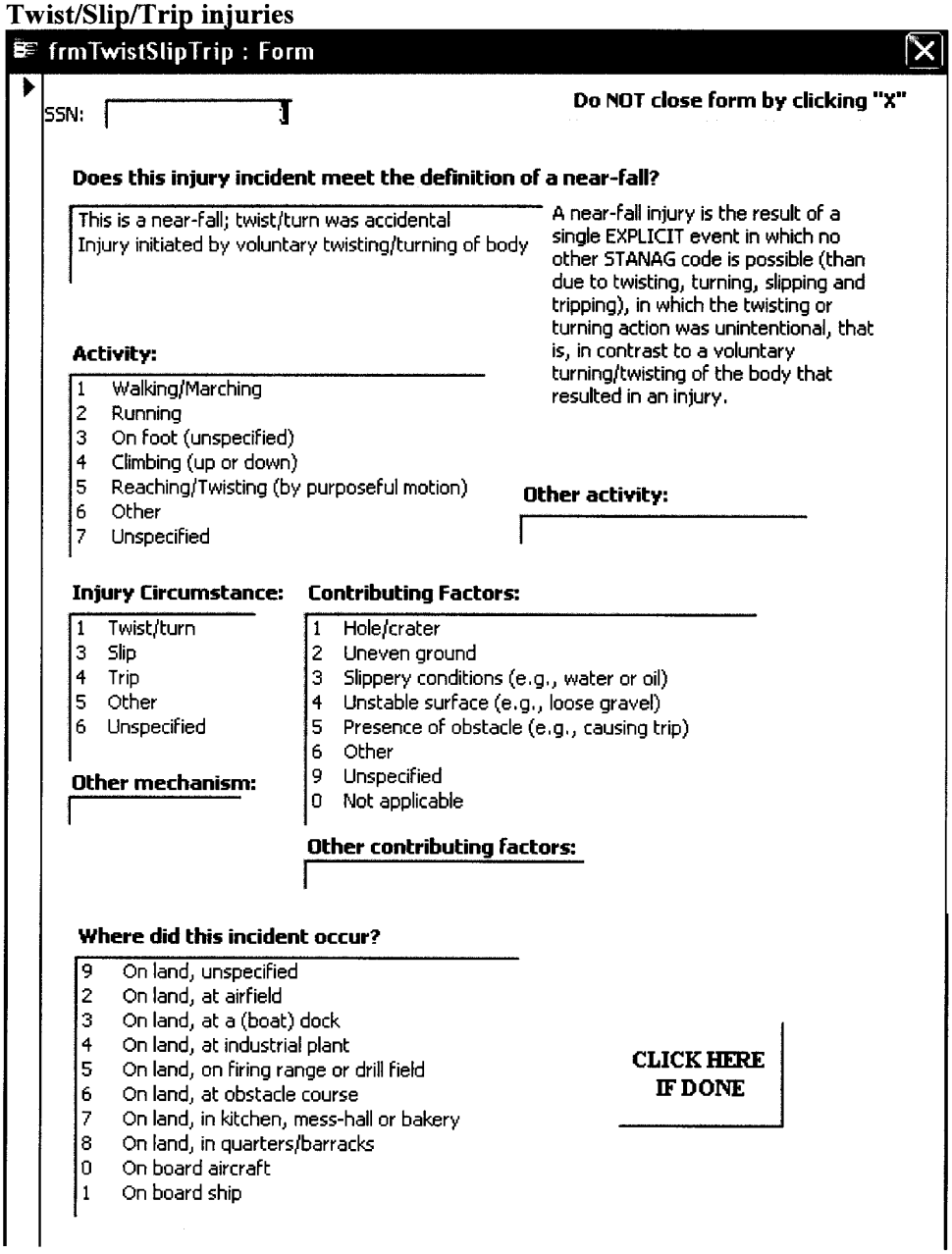
Activity:

3	On foot (unspecified)
6	Other
10	Jumped from stationary vehicle
11	Jumped from moving vehicle

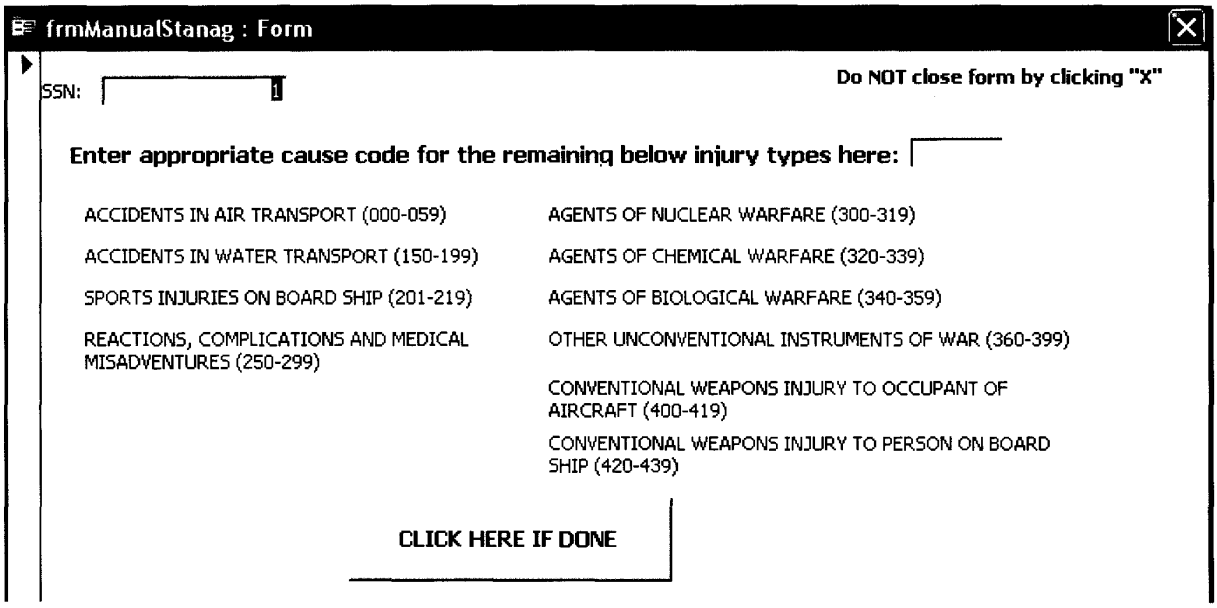
Other activity:

CLICK HERE IF DONE

Twist/Slip/Trip injuries



Other causes



Appendix E
TOP 10 INJURY CAUSE CATEGORIES

Cause of Injury	Frequency (n)	Percent (%)
Falls/Jumps	1047	17.9
Sports and physical training	1042	17.8
Motor vehicle-related crashes	958	16.4
Crushing or blunt trauma	503	8.6
Lifting, pushing, pulling	484	8.3
Twisting, turning, slipping	399	6.8
Shoes, clothing, body armor	234	4.0
Cutting and piercing	183	3.1
Instruments of war, own	174	3.0
Environmental	167	2.9
Other specified	654	11.2
Total	**5845**	**100**

[1]Inludes injuries for which the cause of injury was specified in TRAC[2]ES (65.6%)